Geant4 simulation for the MuCool Test Area (MTA)

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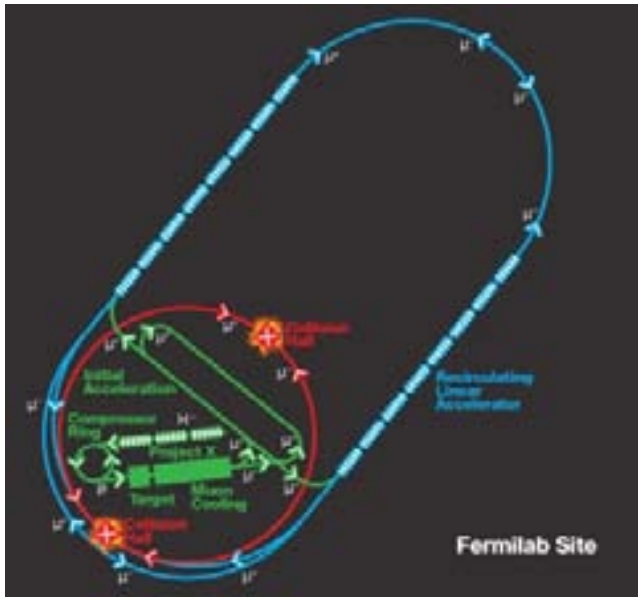
Introduction

Global goal

To build a Muon Collider

Parts of the collider complex:

- Project X
- Muon Cooling
- Detectors at collision halls
- ...



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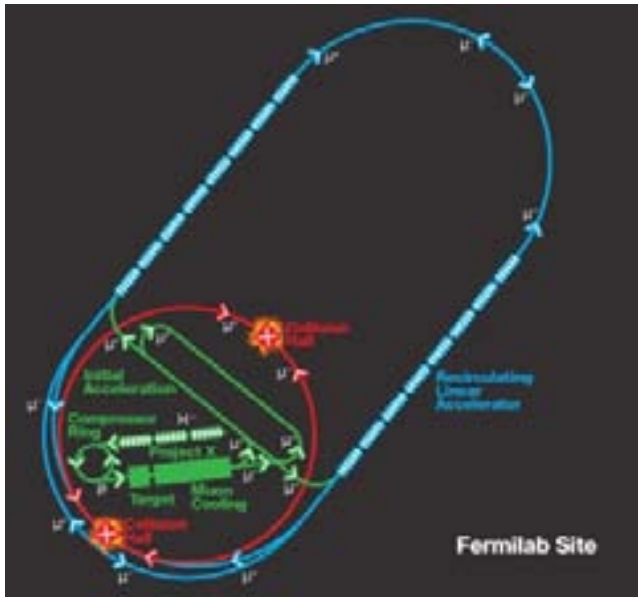

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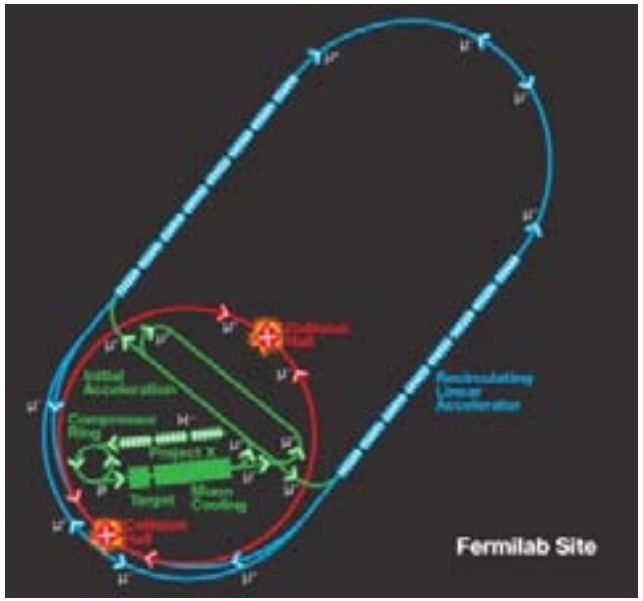
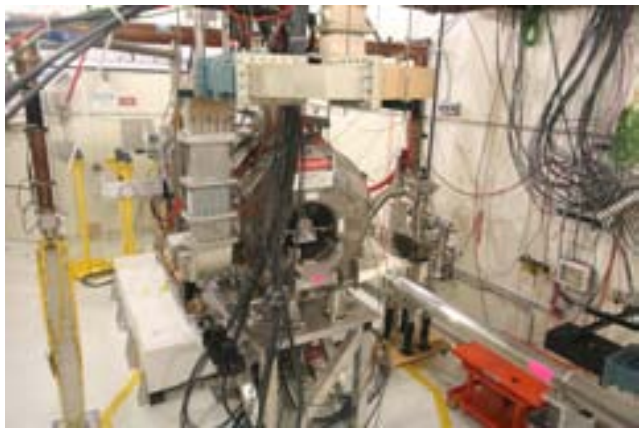




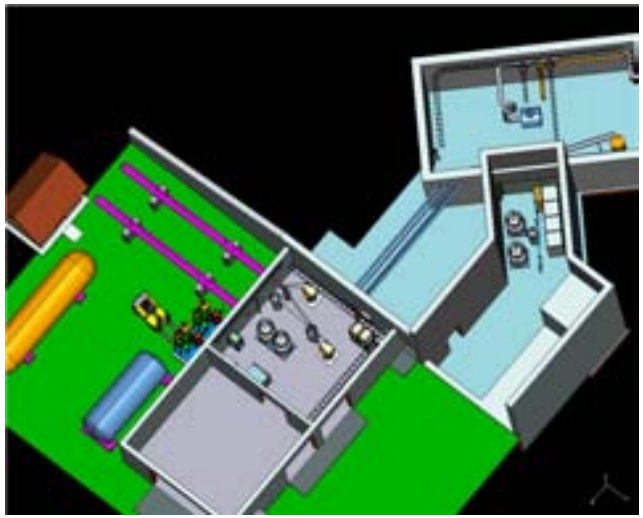
Muon Cooling

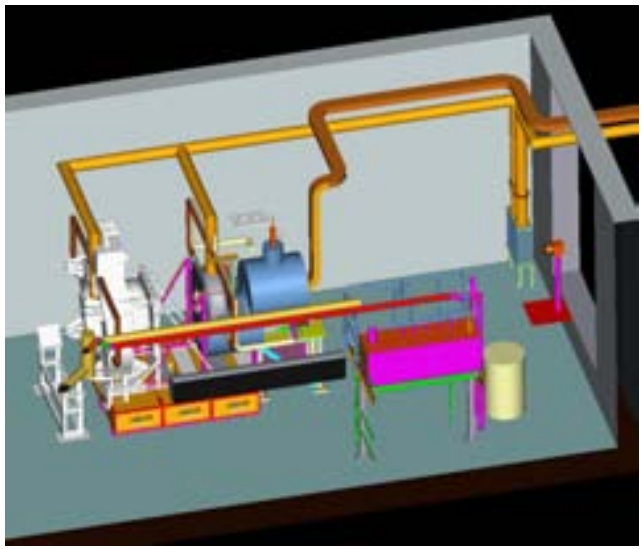
MuCool Test Area

MuCool Test Area

Dedicated facility for muon ionization cooling component R&D

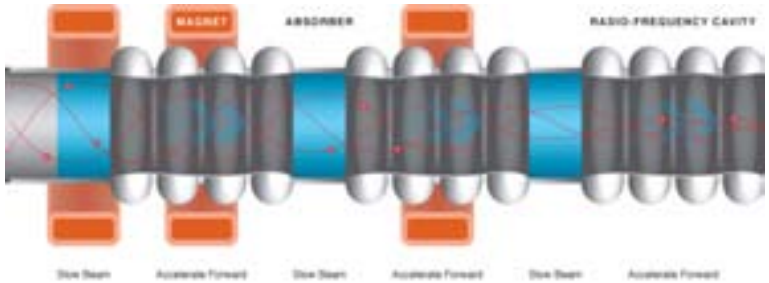
- Surface building with cryogenic plant
- Underground experimental hall
- 201 and 805-MHz RF power
- Superconducting solenoid magnet
- 400-MeV H- beamline (from Linac)
- Radiation detectors





HPRF beam test

- Ionization cooling requires RF cavities operating in strong external magnetic fields



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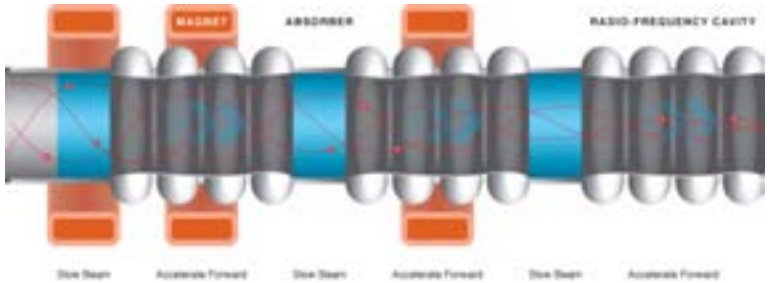
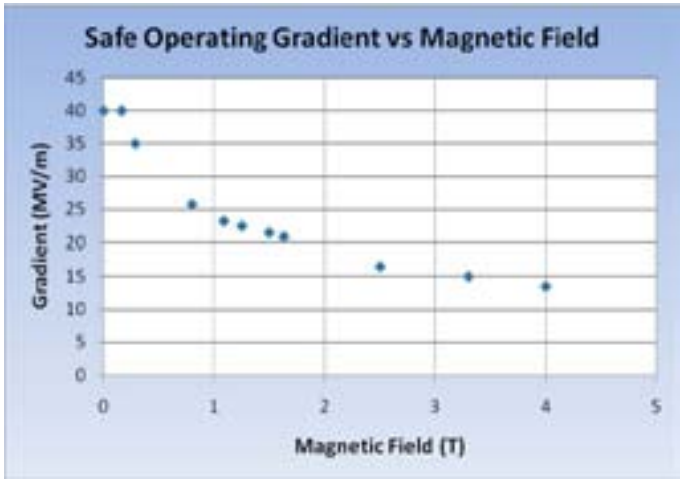


- Poor performance of vacuum cavities in B field



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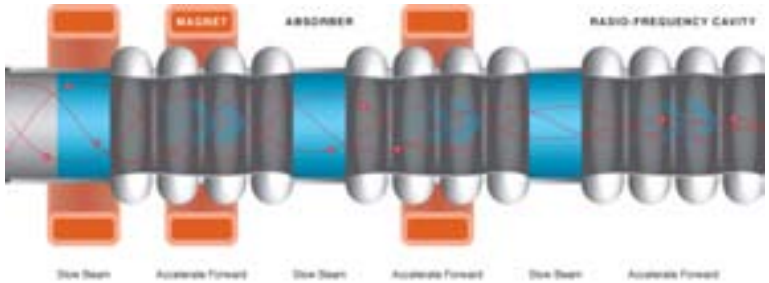
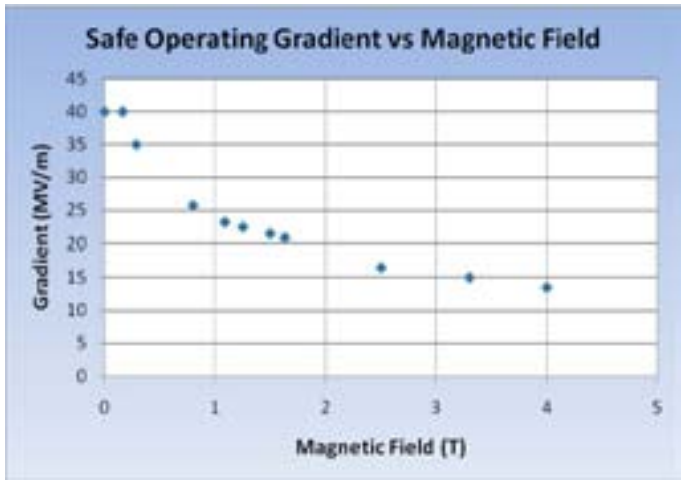
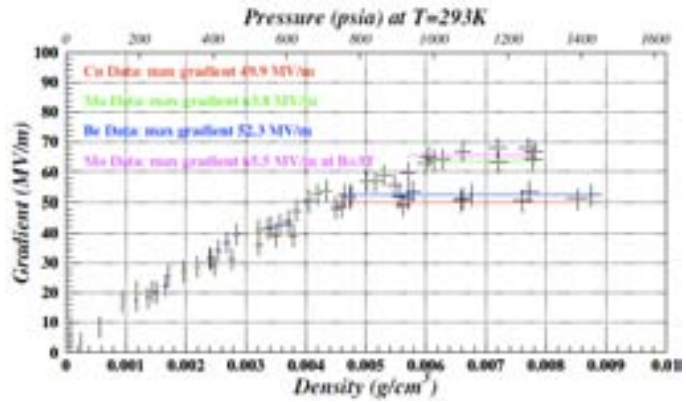


- Poor performance of vacuum cavities in B field
- High pressure GH2-filled RF (HPRF) cavities not affected by magnetic field (past MTA experiments)





HPRF beam test

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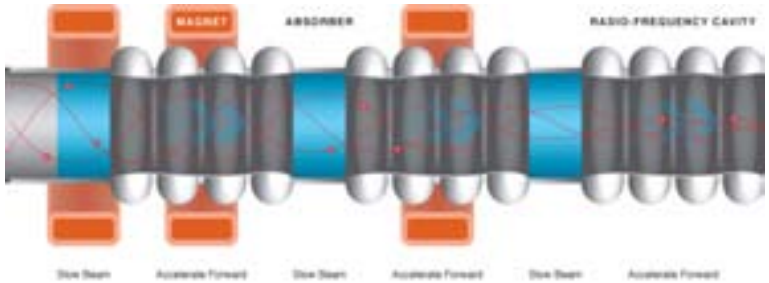
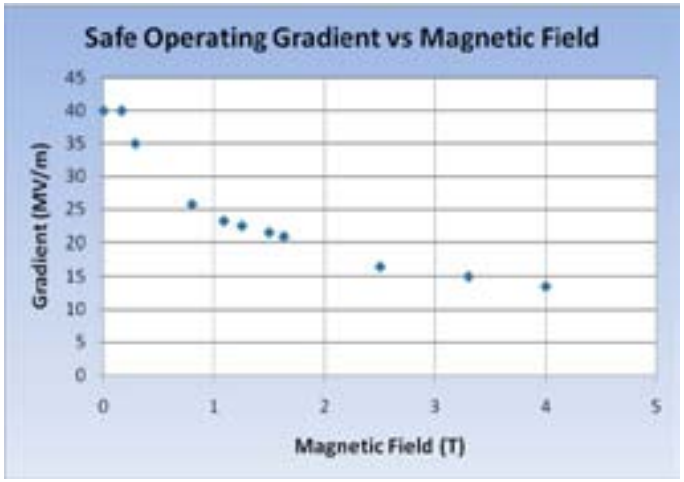
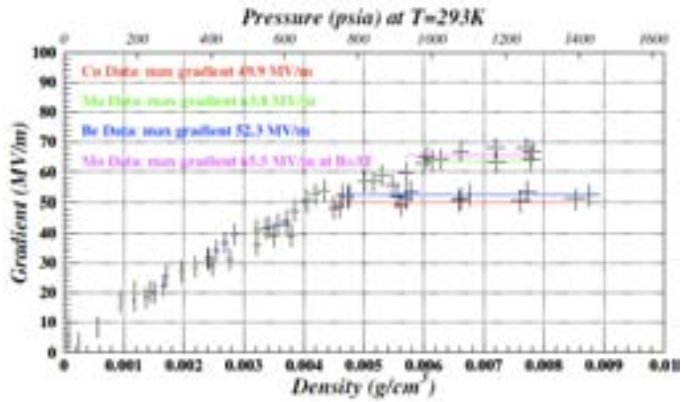


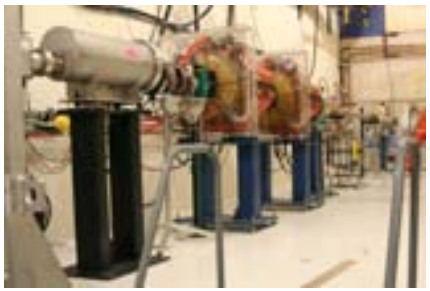
- Poor performance of vacuum cavities in B field
- High pressure GH2-filled RF (HPRF) cavities not affected by magnetic field (past MTA experiments)
- but response of HPRF to intense beam was unknown
  beam induced plasma expected to load cavity
- experiment at MTA built to test cavity in beam
  performed Jul–Aug 2011

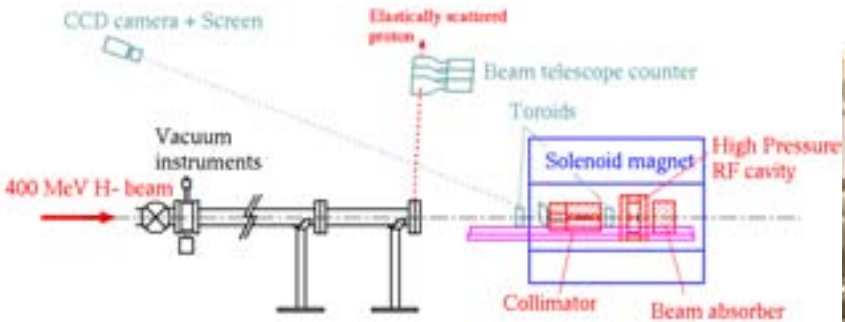


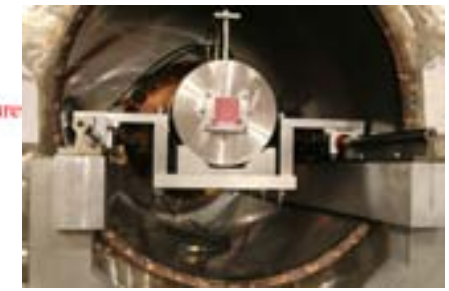


Project Goals

- Build GEANT4 model of MTA experimental setup
  - Beam, solenoid, collimators, HPRF cavity, beam absorber







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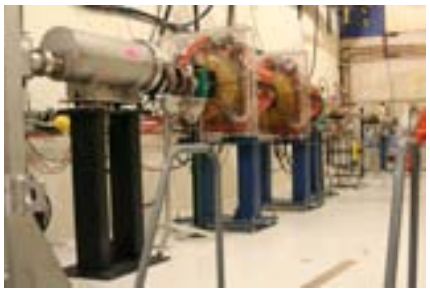
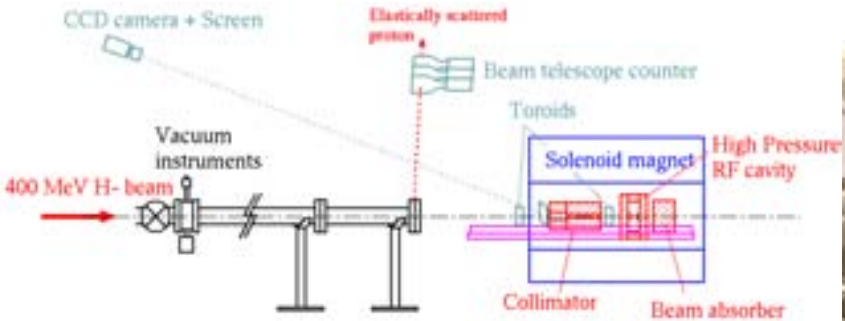
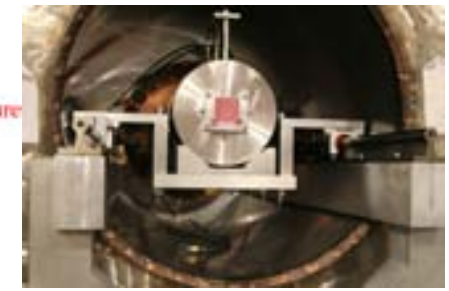
- including diagnostics
  - toroids, phosphor screen







Project Goals

- Build GEANT4 model of MTA experimental setup
  - Beam, solenoid, collimators, HPRF cavity, beam absorber
- including diagnostics
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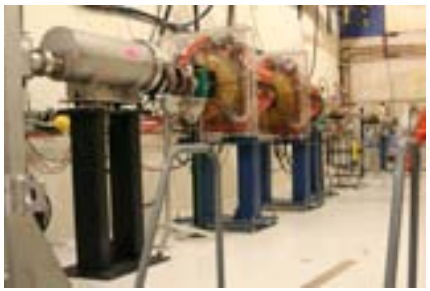
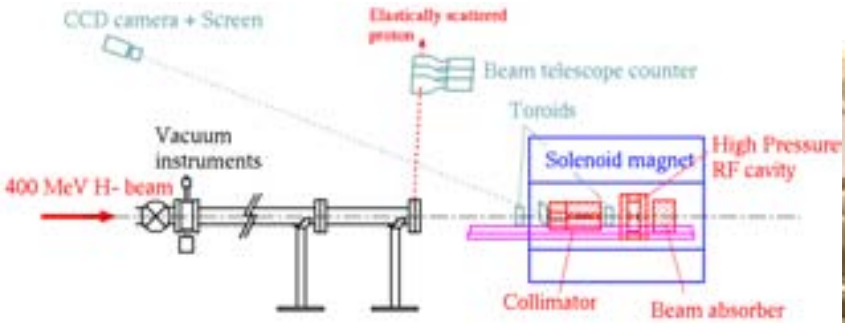
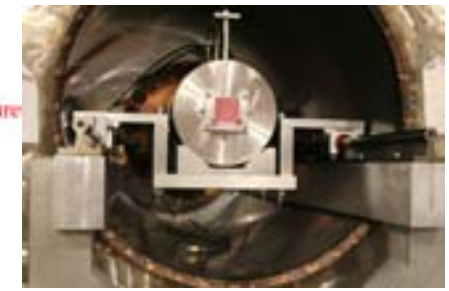
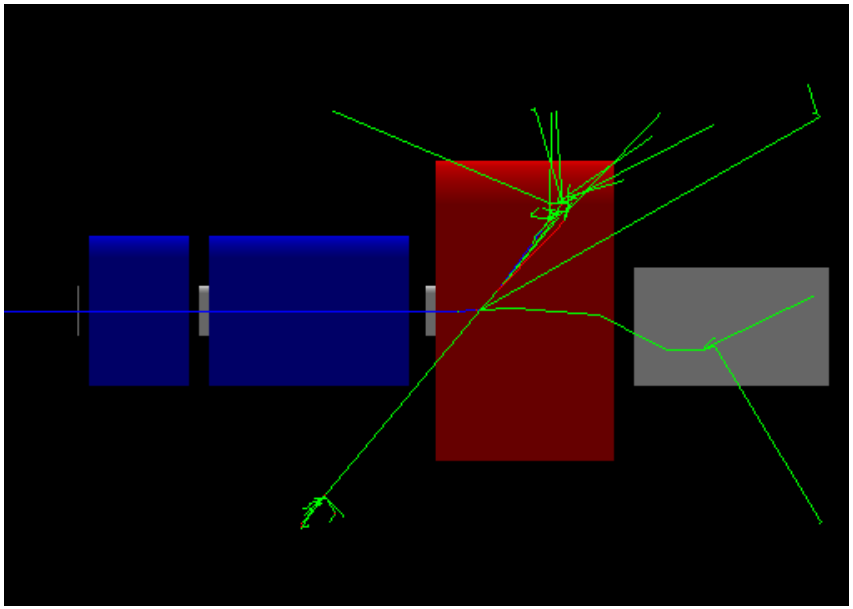
- Study several aspects of HPRF cavity beam test
  - Beam transmission through collimators
  - Measured current vs number of beam particles through toroids
  - Beam profile on screen

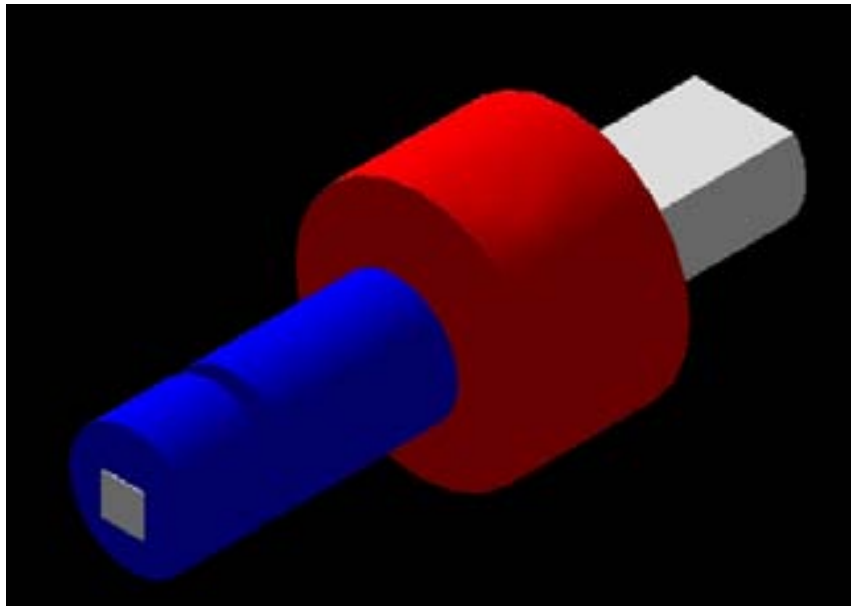


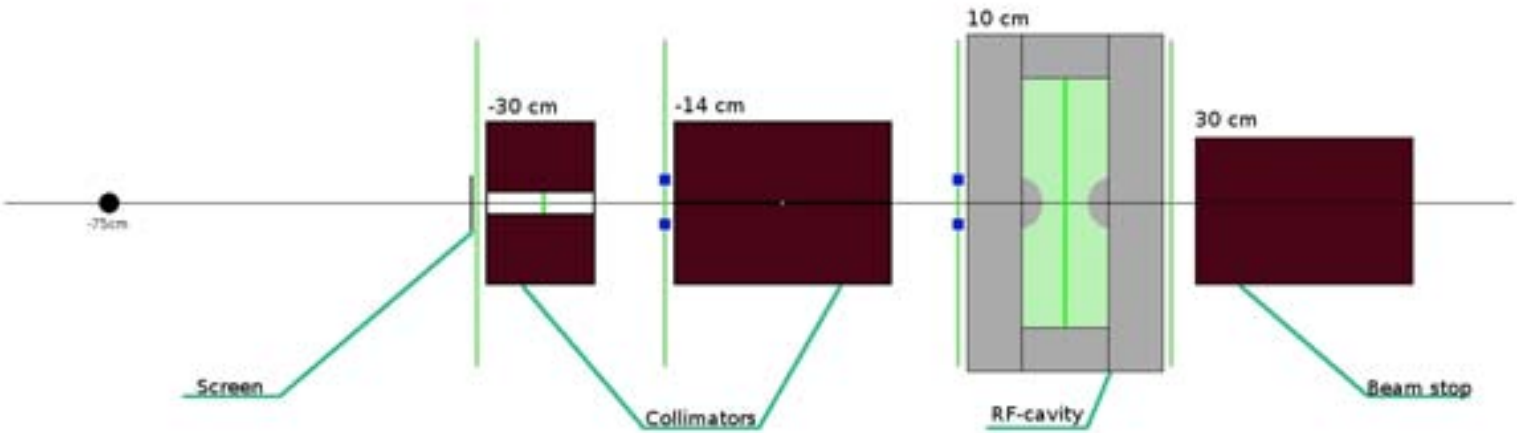




Geometry of the simulation



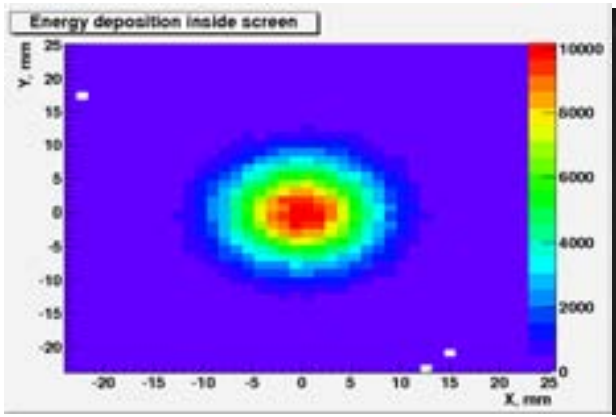


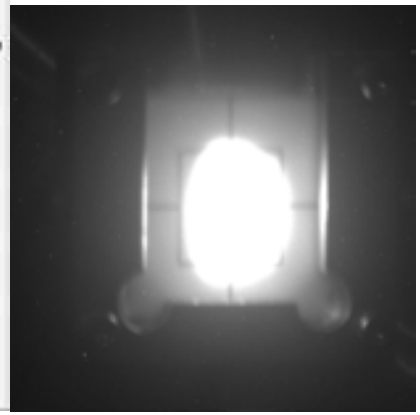


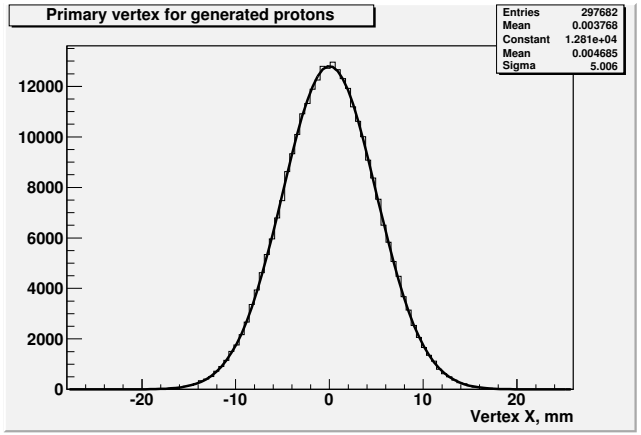
Beam parameters

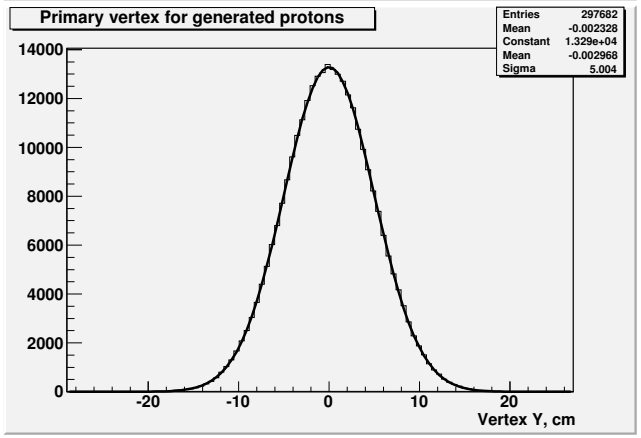
Parameters of generated beam:

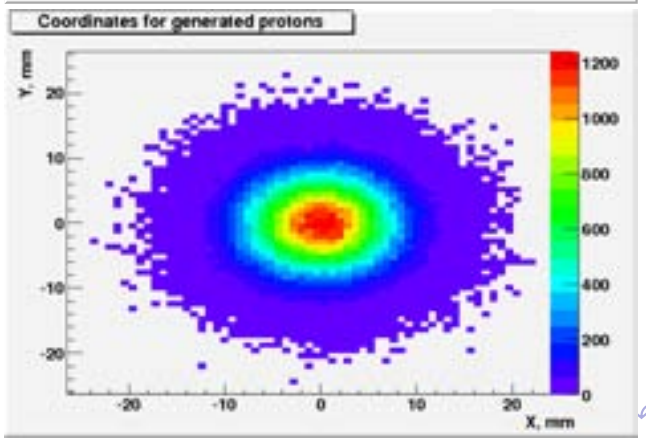
- Beam consists of protons
- $\sigma_x = 5$ mm, $\sigma_y = 5$ mm
- Kinetic Energy = 400 MeV
- Beam is parallel to Z-axis
- There is a screen to monitor the beam profile before the first collimator



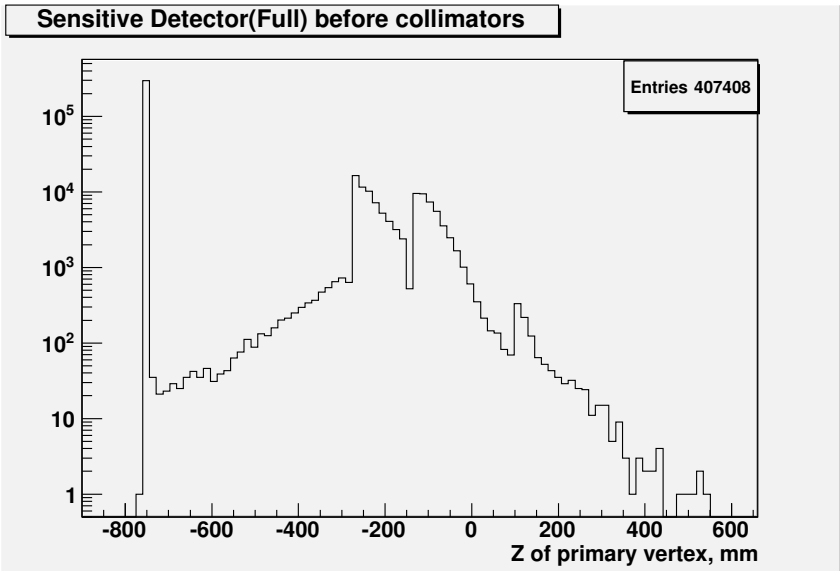


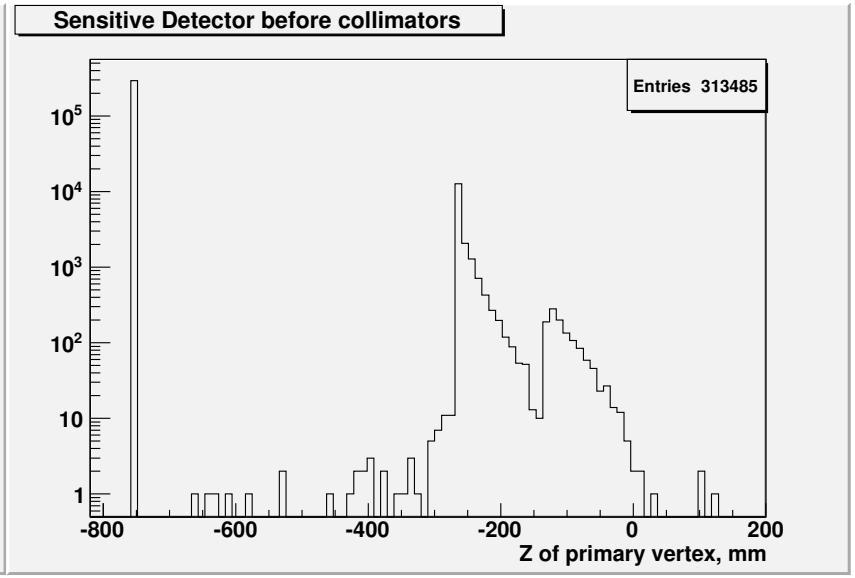


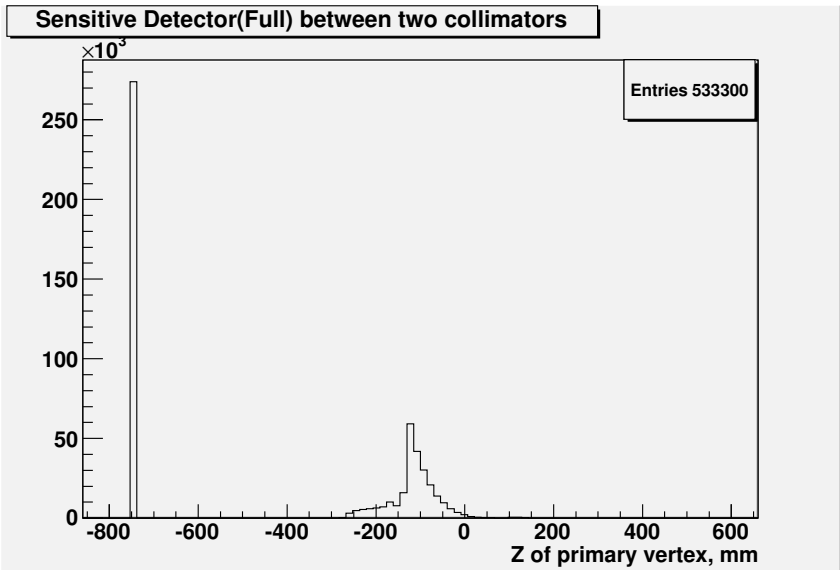


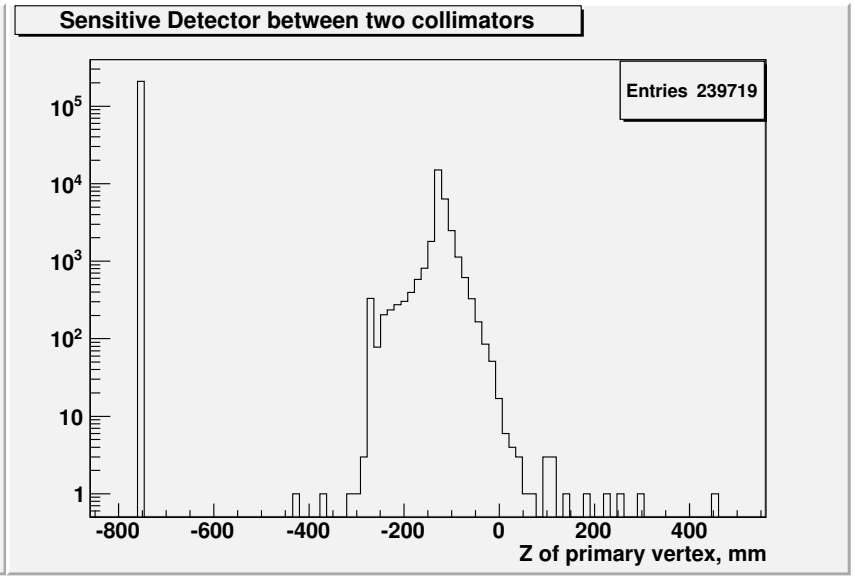


Particle position at birth









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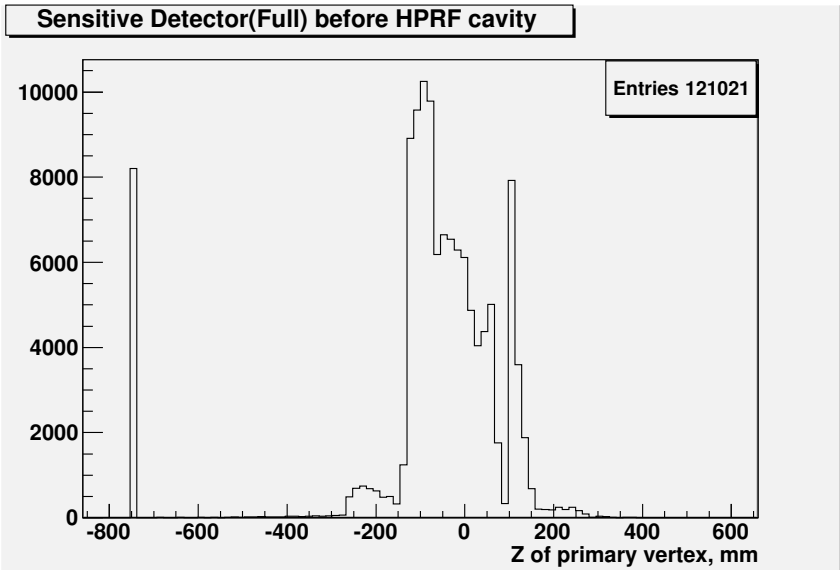
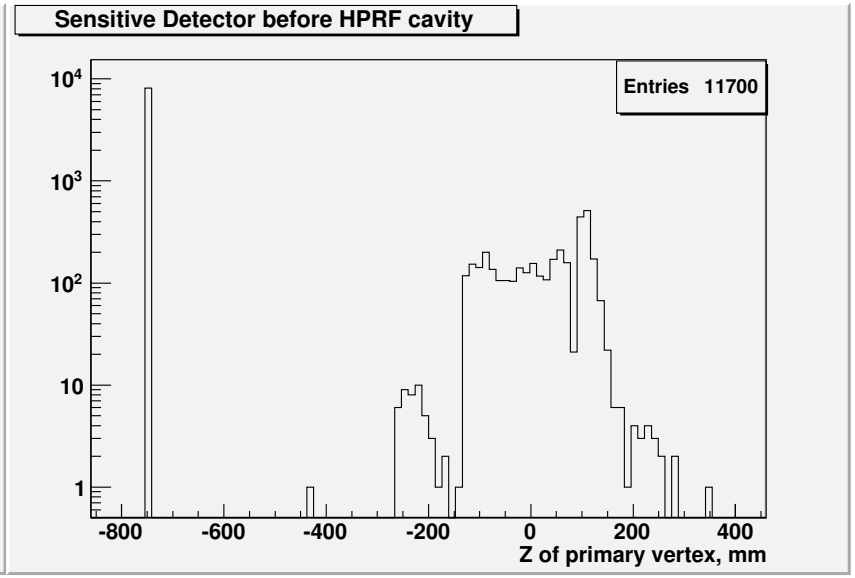
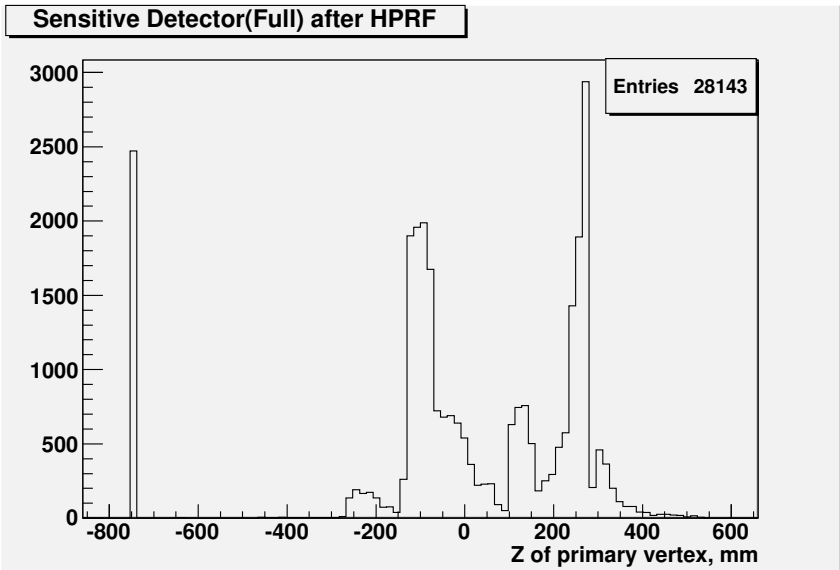
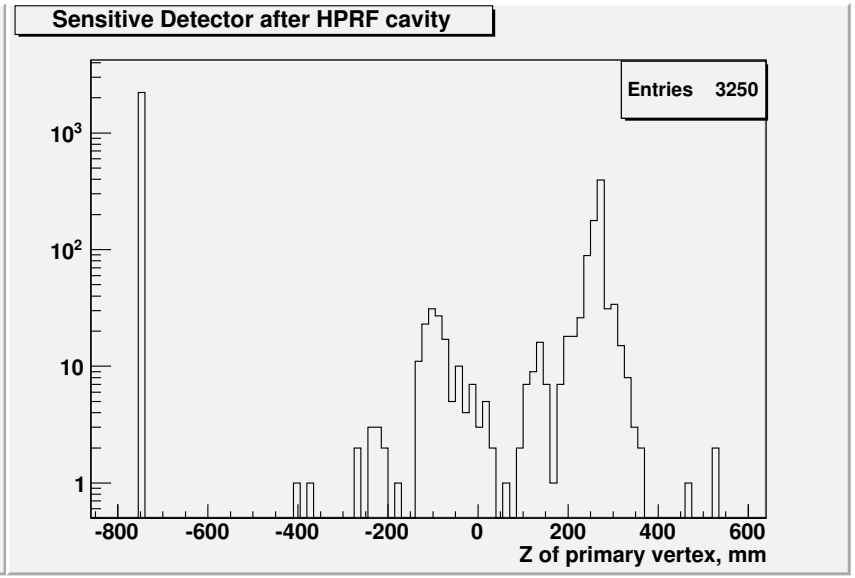


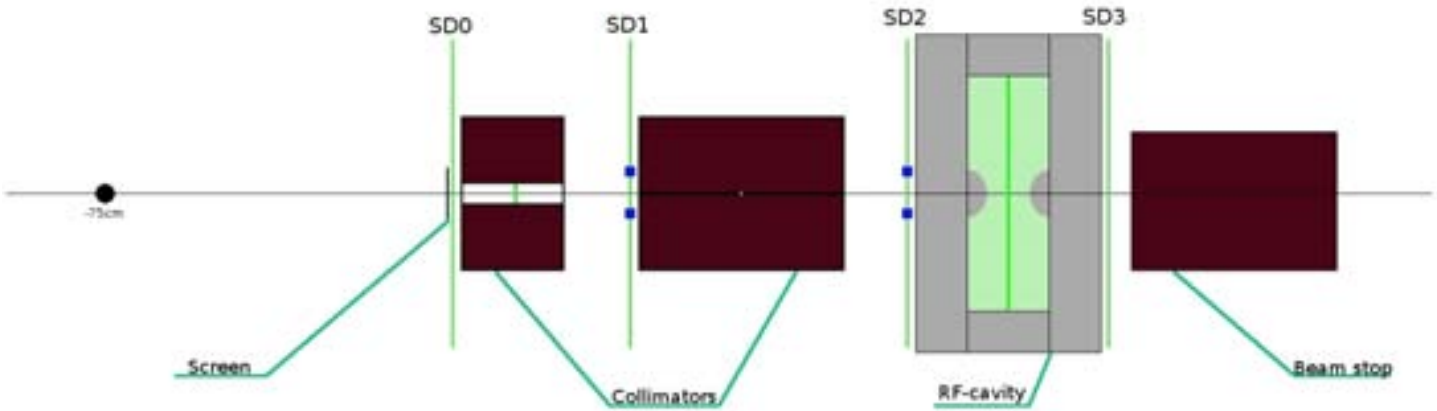






Particle current through Sensitive detector

SD	Proton current	Total current	TC/PC	Transmission
SD0	297682	292679	0.9832	0.9923
SD1	273792	272834	0.9965	0.9126
SD2	8194	8112	0.99	0.0273
SD3	2471	2252	0.9114	0.0082



Summary

- ✓ HPRF beam test geometry modeled in GEANT4
- ✓ Beam profile on screen
- ✓ Transmission through collimators
- ✓ Current through toroids
- Future work: vary beam parameters, add detailed low energy physics, energy deposition in Cavity body and gas